

Observer-Triggered Reconnection Closure with Conservative Energy Routing

Abstract

A bounded, state-triggered anomalous resistivity closure is formulated for fluid, two-fluid, and magnetohydrodynamic plasma models. The closure introduces a logistic-gated effective resistivity term that activates when a diagnostic quantity W exceeds a threshold W_c . All dissipation associated with the anomalous term is conservatively routed into an internal or subgrid energy reservoir to ensure strict total-energy conservation. The formulation is dimensionally consistent, bounded, and compatible with standard magnetic reconnection diagnostics. Guardrails are specified to prevent double-counting in kinetic frameworks, and falsifiable A/B verification procedures and stress-test regimes are provided.

Governing Equations

The generalized Ohm's law in collisionless-ready form is adopted, incorporating convective, resistive, Hall, pressure-tensor, and electron-inertia contributions.

Effective Resistivity Closure

The effective resistivity is decomposed into a baseline term and a bounded, observer-triggered anomalous component gated by a logistic sigmoid and a finite temporal ramp.

Energy Routing and Conservation

All anomalous dissipation is routed into an internal or subgrid energy density, ensuring strict total-energy conservation under closed or explicitly flux-accounted domains.

Verification and Stress Tests

A/B comparison procedures, convergence tests, and parameter stress regimes are specified to ensure falsifiability and robustness.